



IMAAC

Interagency Modeling and Atmospheric Assessment Center

Real World

Benzene Release at Petrochemical Depot Deer Park, TX – Best Estimate

26MAR2019 1045Z

RFI – 19 – 0254sU

26MAR2019

Requestor: NWS – Houston WFO

Distribution authorized to U.S. Government agencies and
their contractors for administrative/operational use.

Date: 03/26/2019

Other requests for this document shall be referred to:

Defense Threat Reduction Agency

8725 John J. Kingman Rd, MS 6201

Fort Belvoir, VA 22060-6201



Request Summary

• Request Data

- Requestor: Brian Kyle, Lead Forecast Meteorologist, National Weather Service – Houston WFO
- Contact: 1-800-846-1828, sr-hgx.ops@noaa.gov
- Request: Downwind hazard for a benzene release in Deer Park, TX as a consequence of the petrochemical fire earlier this week.

• Solution

- Summary: AEGLs at 8 hours, surface dosage at 36 hours, concentrations at multiple times, and recent readings are provided.
- Employment: Real World
- Reachback: M. Che, R. Lucheta

Deer Park, TX
Latitude: 29.732437° N
Longitude: 95.091517° W

Time: 0400 CDT
Date: 26MAR2019

Hazard:

- Benzene vapor released at 30 kg/min

Weather:

- High Resolution Numerical Weather Prediction: 12 km NAM from NCEP (CONUS)
- Initialized: 06Z 26MAR2019



Modeling Summary – Best Estimate

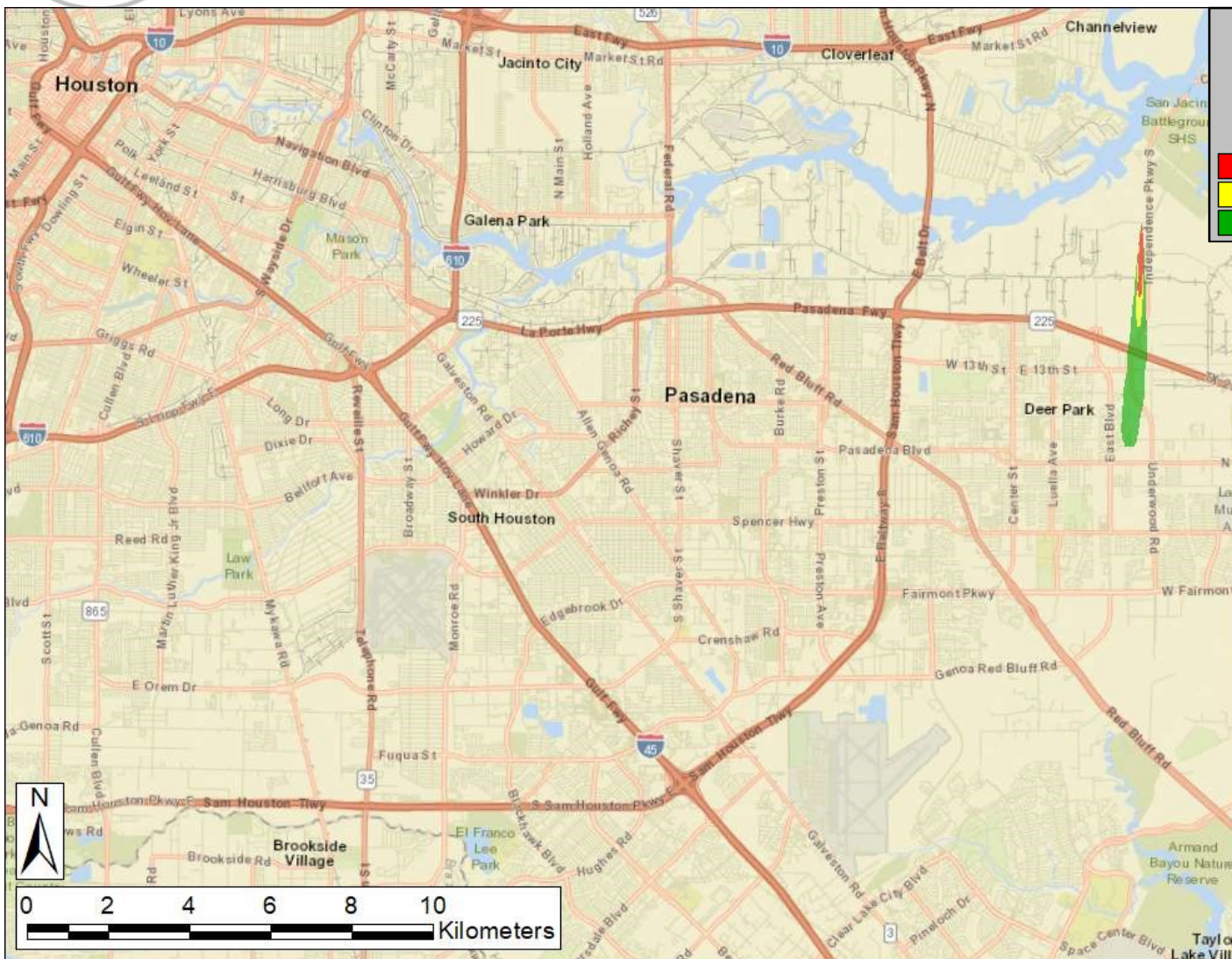
- Known Information: An unknown source at the site of the Deer Park fire is releasing benzene. Current rate and location are unknown. There is no fire currently burning.
- Readings on 25 Mar indicated benzene concentrations near the tanks close of approx. 20 ppm. Most nearby air monitoring sensors in the surrounding area are only measuring less than 0.499 ppm.
- Beginning with the above, Reachback modeled a continuous release of benzene vapor at a rate of 60 kg/min, which is referred to as the “worst case”. This produced results that seemed roughly consistent with the 25 Mar readings at the tank farm while still providing a margin of safety.
- Subsequent to this, the number of tanks containing benzene was reduced. In the absence of specific data, this was accounted for by further reducing the flow rate to 30 kg/min. This is referred to as the “best estimate”.
- **Benzene is mildly toxic – serious effects require exposures to hundreds or thousands of ppm for sustained periods of time.**



Modeling Caveats

- The rate of benzene release should have some degree of time variance as local temperatures change, but this was not accounted for in the model.
- There may be some thermal lofting of the benzene occurring, but that could not be determined definitively.
- Matching data to model plume calculations is inherently difficult due to the meander and intermittency of real world plume transport and dispersion. These small-scale effects produce a randomness that can be captured in the model but not predicted a priori. **This small-scale variability can cause sensors in very close proximity to produce wildly different results.**

Benzene Conc. @ Ground Level; 0600 CDT 26-MAR (Far View)



Benzene(Total) Concentration 26-Mar-19 11:00:00Z (2.000 hr)		
	kg/m3	In contour population
1 ppm	3.19E-06	62
0.5 ppm	1.595E-06	74
0.1 ppm	3.19E-07	3,704

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

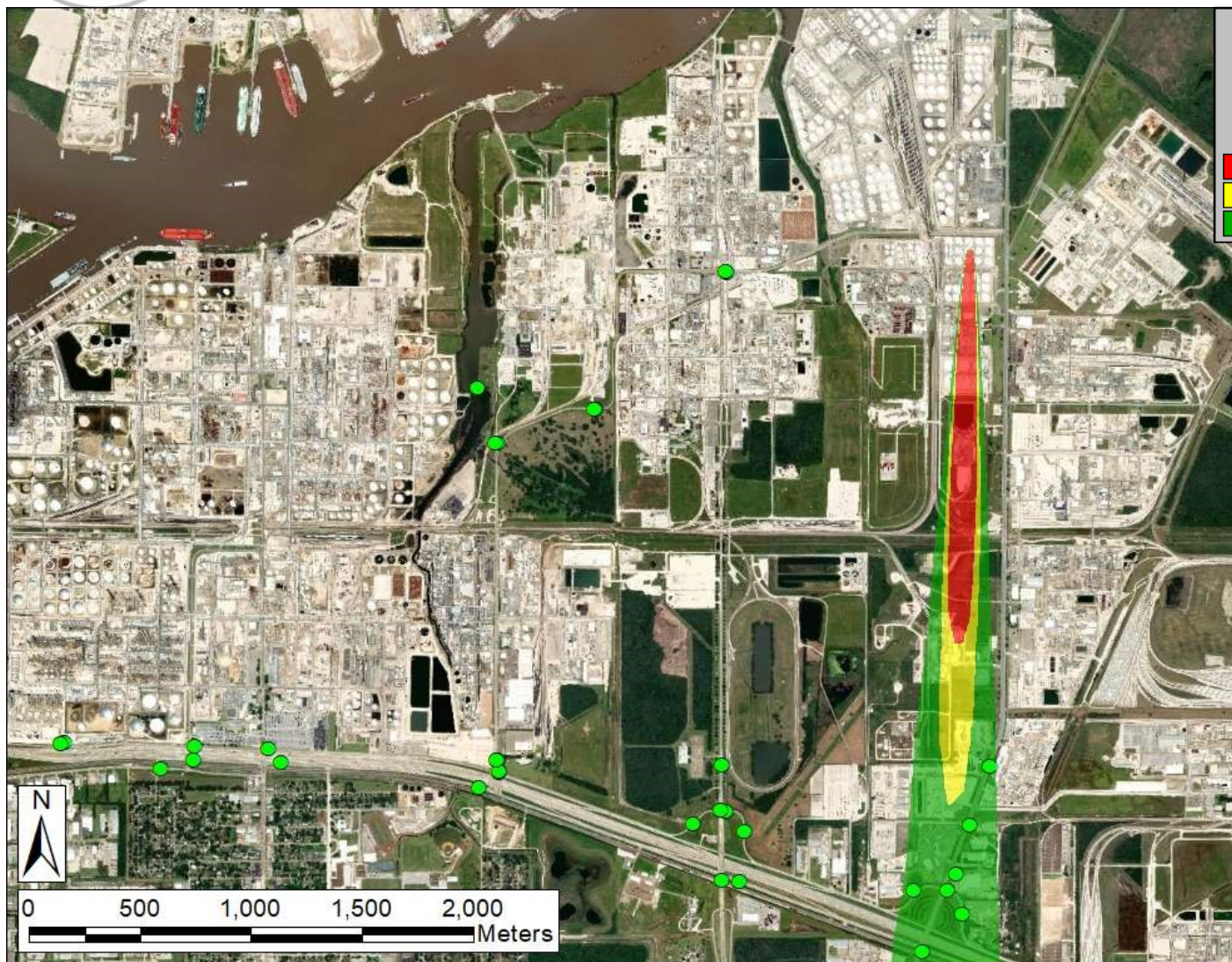
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 0600 CDT 26-MAR (Near View)



Benzene(Total) Concentration 26-Mar-19 11:00:00Z (2.000 hr)			In contour population
	kg/m3		
1 ppm	3.19E-06		62
0.5 ppm	1.595E-06		74
0.1 ppm	3.19E-07		3,704

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

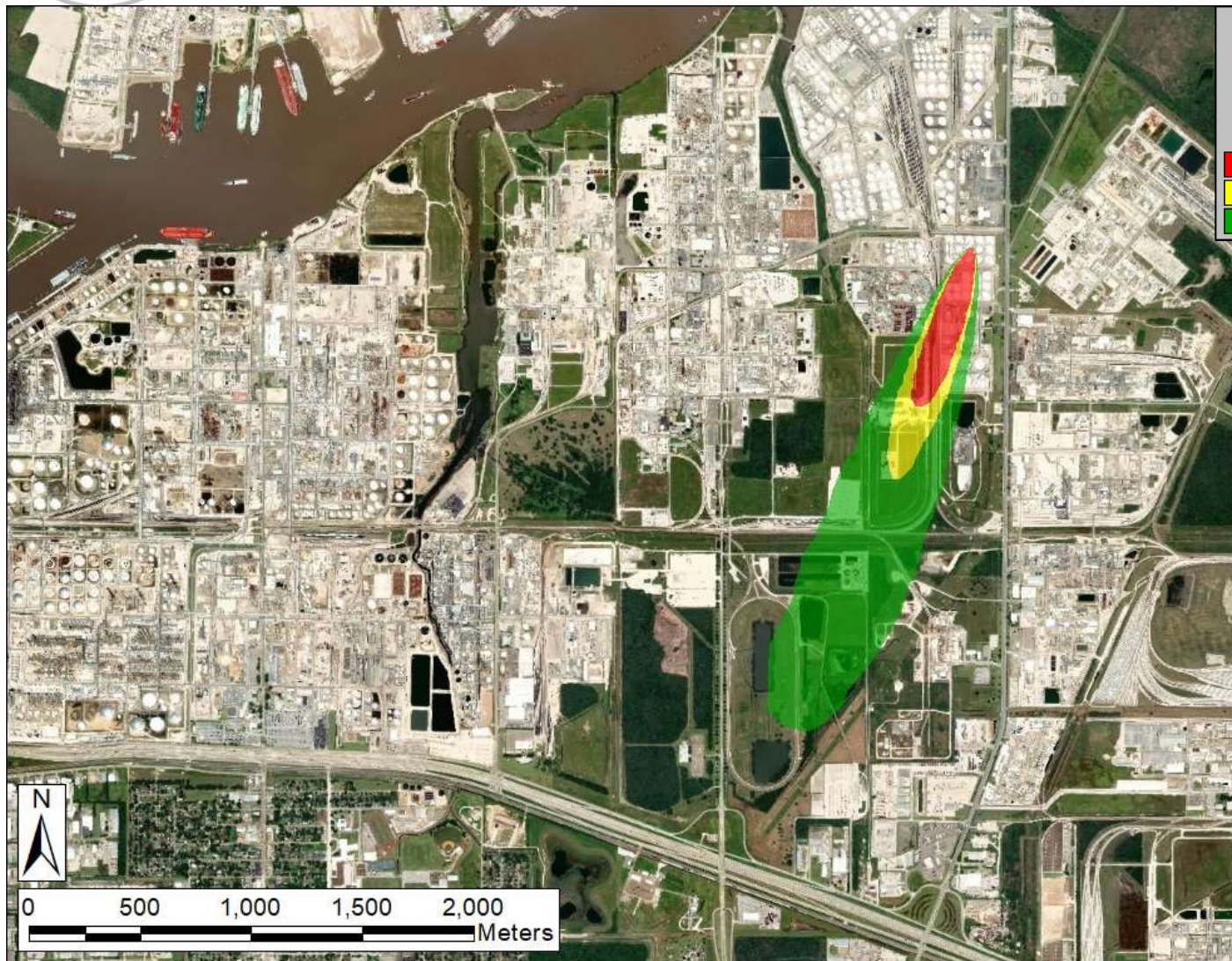
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 0900 CDT 26-MAR



Benzene(Total) Concentration 26-Mar-19 14:00:00Z (5.000 hr)			In contour population
	kg/m3		
1 ppm	3.19E-06		45
0.5 ppm	1.595E-06		63
0.1 ppm	3.19E-07		96

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

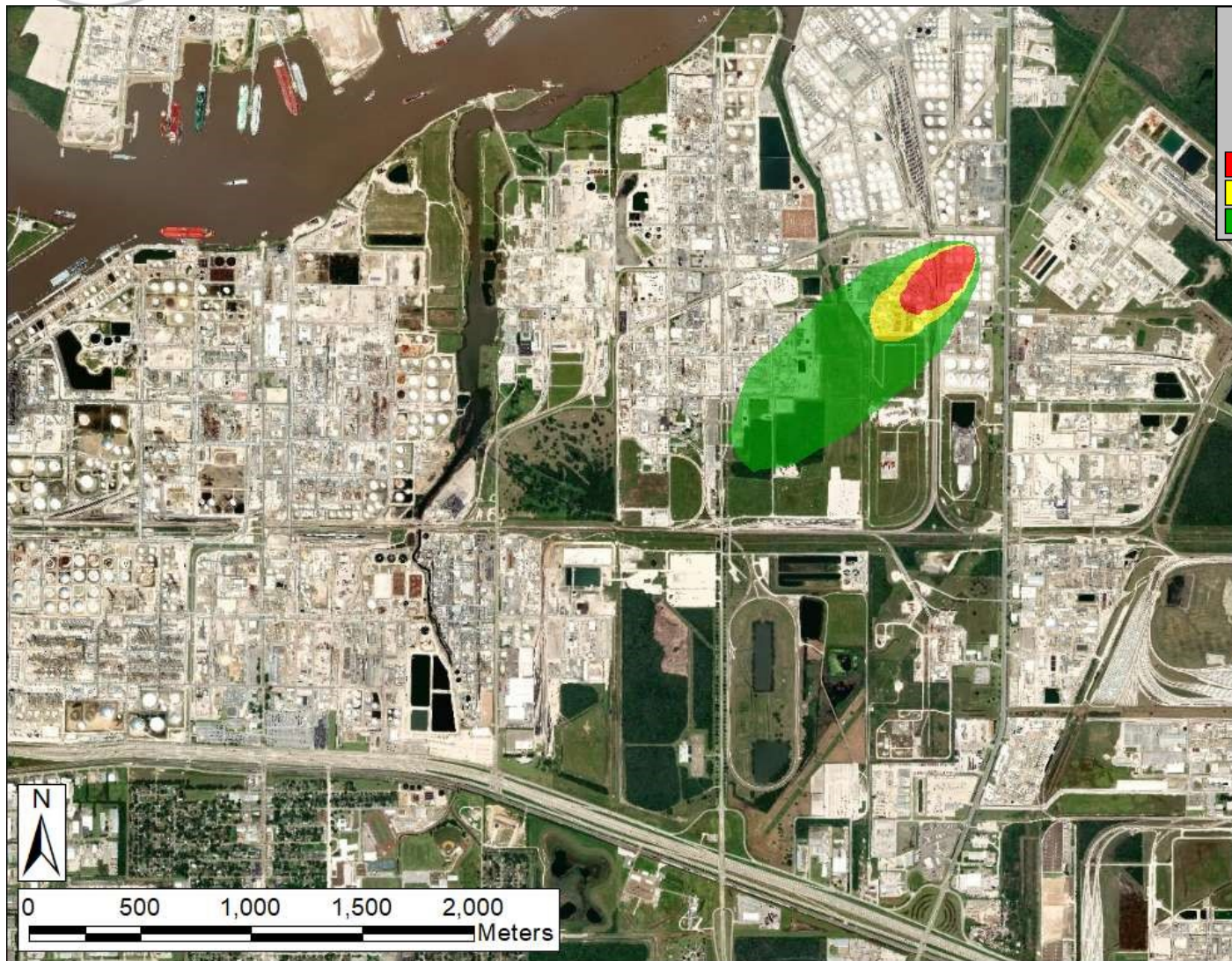
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 1200 CDT 26-MAR



Benzene(Total) Concentration 26-Mar-19 17:00:00Z (8.000 hr)			In contour population
	kg/m3		
1 ppm	3.19E-06		42
0.5 ppm	1.595E-06		65
0.1 ppm	3.19E-07		124

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

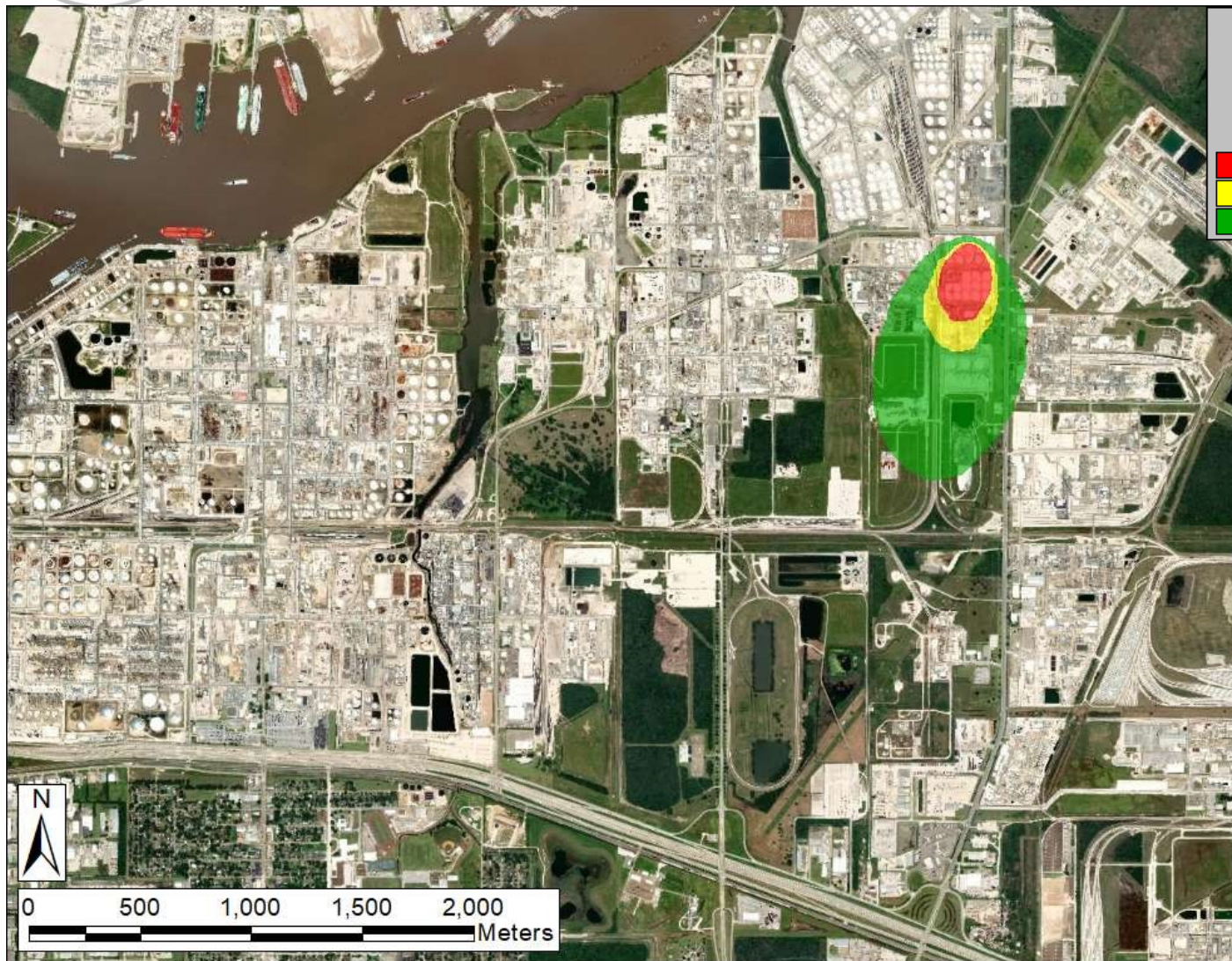
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 1500 CDT 26-MAR



Benzene(Total) Concentration 26-Mar-19 20:00:00Z (11.000 hr)		
	kg/m3	In contour population
1 ppm	3.19E-06	82
0.5 ppm	1.595E-06	95
0.1 ppm	3.19E-07	202

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 2100 CDT 27-MAR (Far View)



Benzene(Total) Concentration 27-Mar-19 02:00:00Z (17.000 hr)		
	kg/m3	In contour population
1 ppm	3.19E-06	17
0.5 ppm	1.595E-06	264
0.1 ppm	3.19E-07	10,788

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

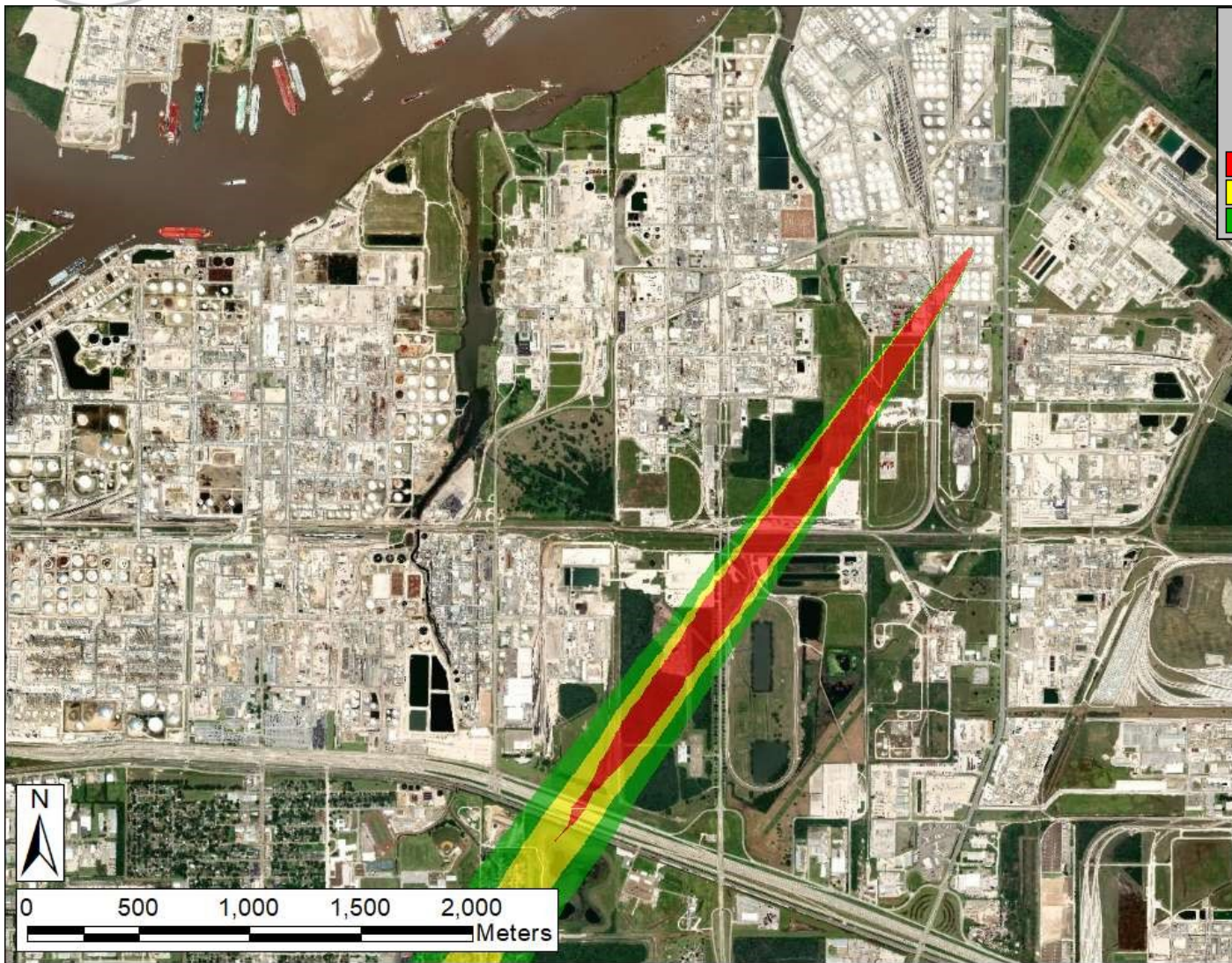
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 2100 CDT 27-MAR (Near View)



Benzene(Total) Concentration 27-Mar-19 02:00:00Z (17.000 hr)		
	kg/m3	In contour population
1 ppm	3.19E-06	17
0.5 ppm	1.595E-06	264
0.1 ppm	3.19E-07	10,788

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 0300 CDT 27-MAR (Far View)



Benzene(Total) Concentration 27-Mar-19 08:00:00Z (23.000 hr)		
	kg/m3	In contour population
1 ppm	3.19E-06	73
0.5 ppm	1.595E-06	153
0.1 ppm	3.19E-07	18,815

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

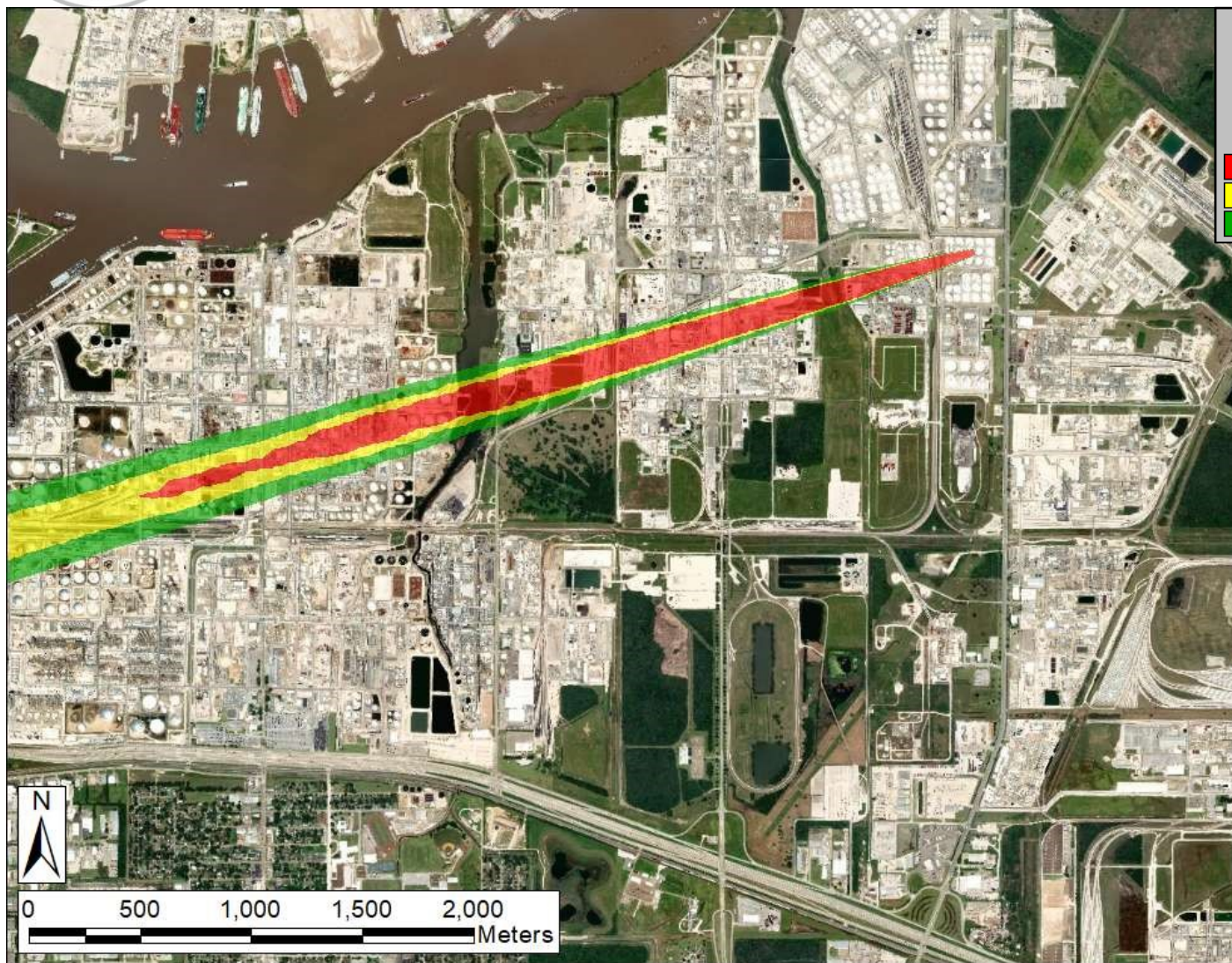
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 0300 CDT 27-MAR (Near View)



Benzene(Total) Concentration 27-Mar-19 08:00:00Z (23.000 hr)		
	kg/m3	In contour population
1 ppm	3.19E-06	73
0.5 ppm	1.595E-06	153
0.1 ppm	3.19E-07	18,815

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

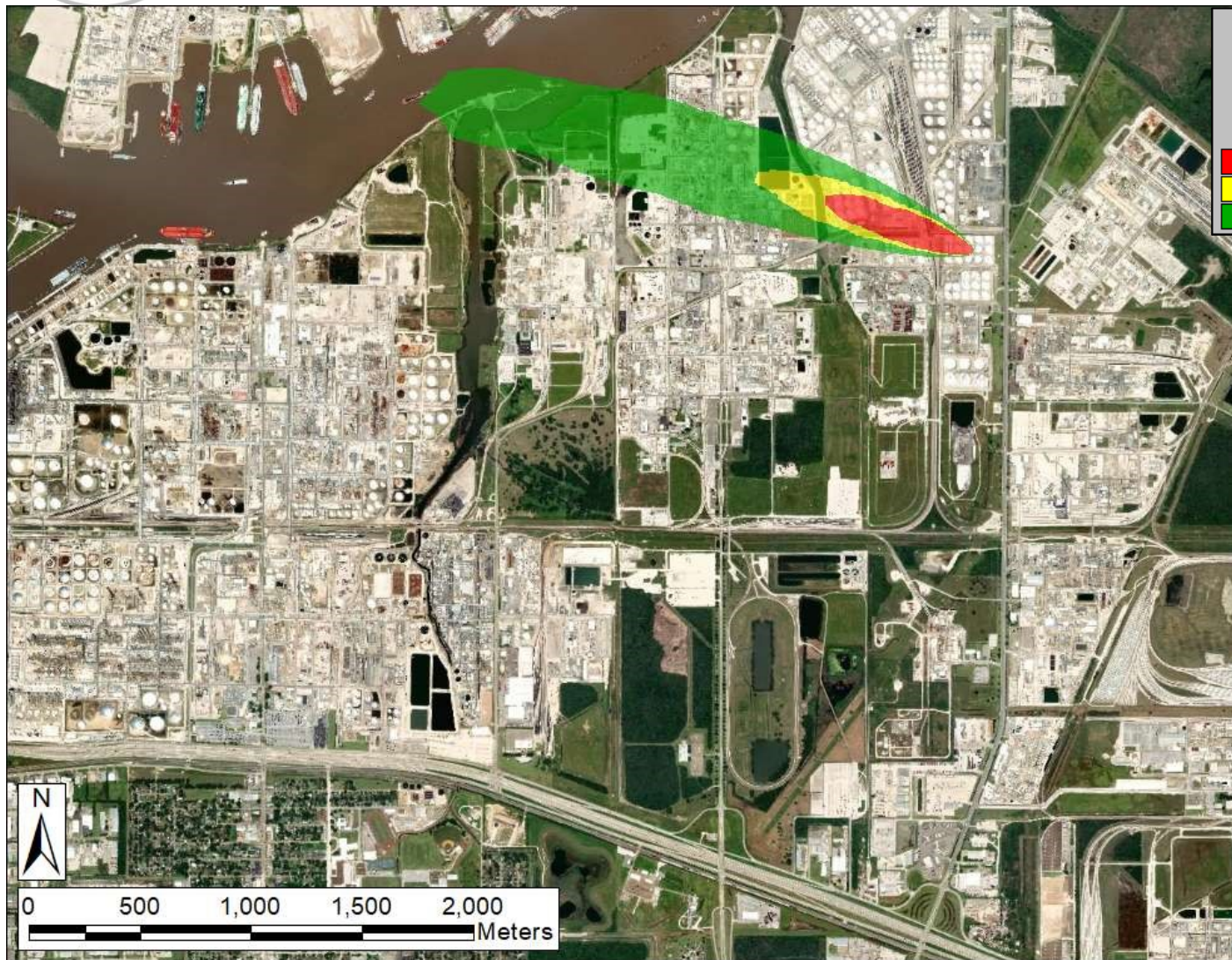
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 0900 CDT 27-MAR



Benzene(Total) Concentration 27-Mar-19 14:00:00Z (29.000 hr)			In contour population
	kg/m3		
1 ppm	3.19E-06		49
0.5 ppm	1.595E-06		83
0.1 ppm	3.19E-07		169

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

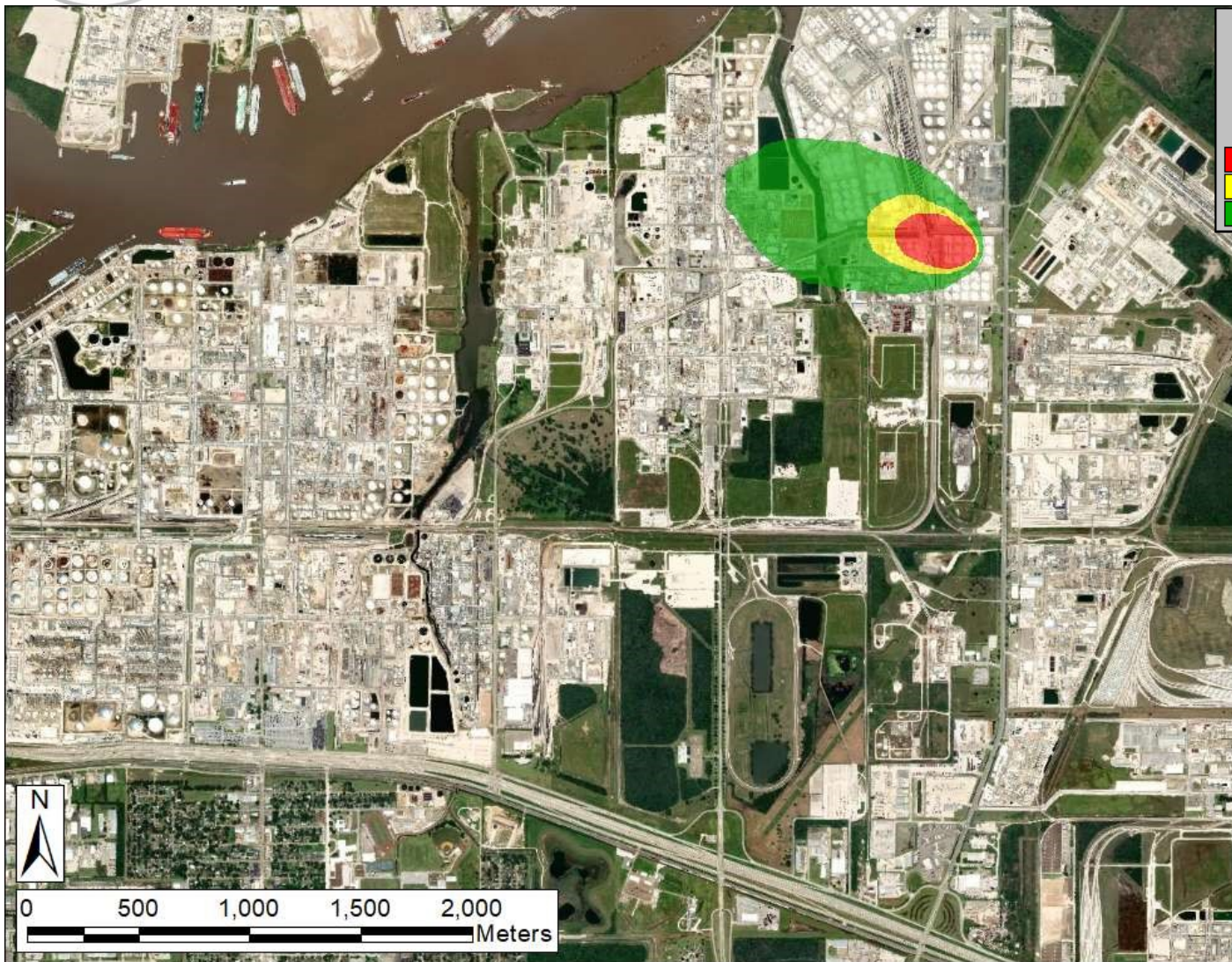
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Benzene Conc. @ Ground Level; 1500 CDT 27-MAR



Benzene(Total) Concentration 27-Mar-19 20:00:00Z (35.000 hr)		
	kg/m3	In contour population
1 ppm	3.19E-06	83
0.5 ppm	1.595E-06	152
0.1 ppm	3.19E-07	441

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

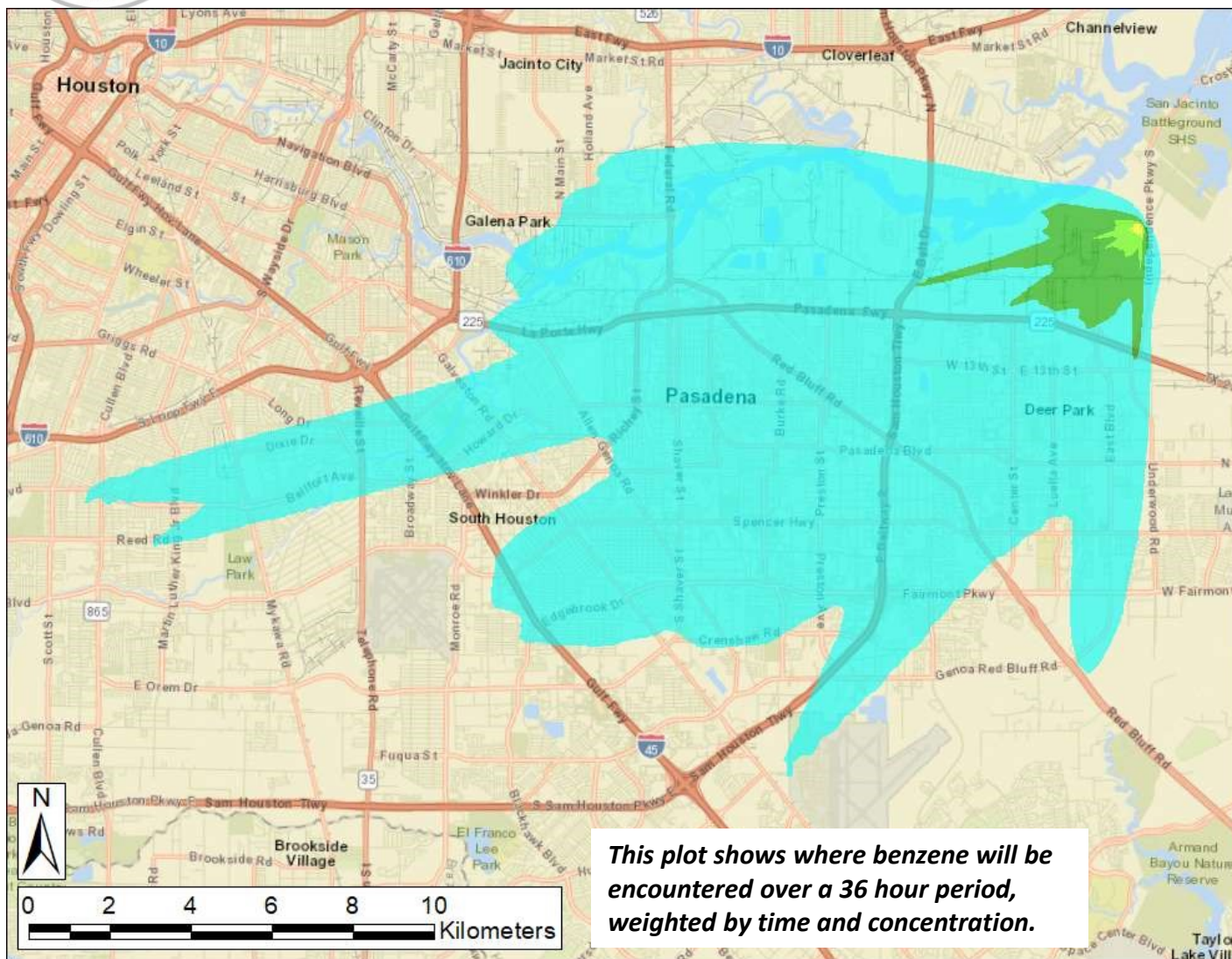
Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Total Accumulated Dosage; 0400 26-MAR – 1600 27-MAR CDT (Far View)



Benzene(Total) Surface Dosage 27-Mar-19 21:00:00Z (36.000 hr)		
	kg-s/m3	In contour area (km ²)
100.0	100.0	2.20E-4
10.0	10.0	4.65E-3
1.0	1.0	5.85E-2
0.1	0.1	0.632
0.01	0.01	7.784
0.001	0.001	196.393

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:

LandScan 2017

This plot shows where benzene will be encountered over a 36 hour period, weighted by time and concentration.



Total Accumulated Dosage; 0400 26-MAR – 1600 27-MAR CDT (Near View)

This plot shows where benzene will be encountered over a 36 hour period, weighted by time and concentration.

Benzene(Total) Surface Dosage 27-Mar-19 21:00:00Z (36.000 hr)		
	kg-s/m3	In contour area (km ²)
100.0	100.0	2.20E-4
10.0	10.0	4.65E-3
1.0	1.0	5.85E-2
0.1	0.1	0.632
0.01	0.01	7.784
0.001	0.001	196.393

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

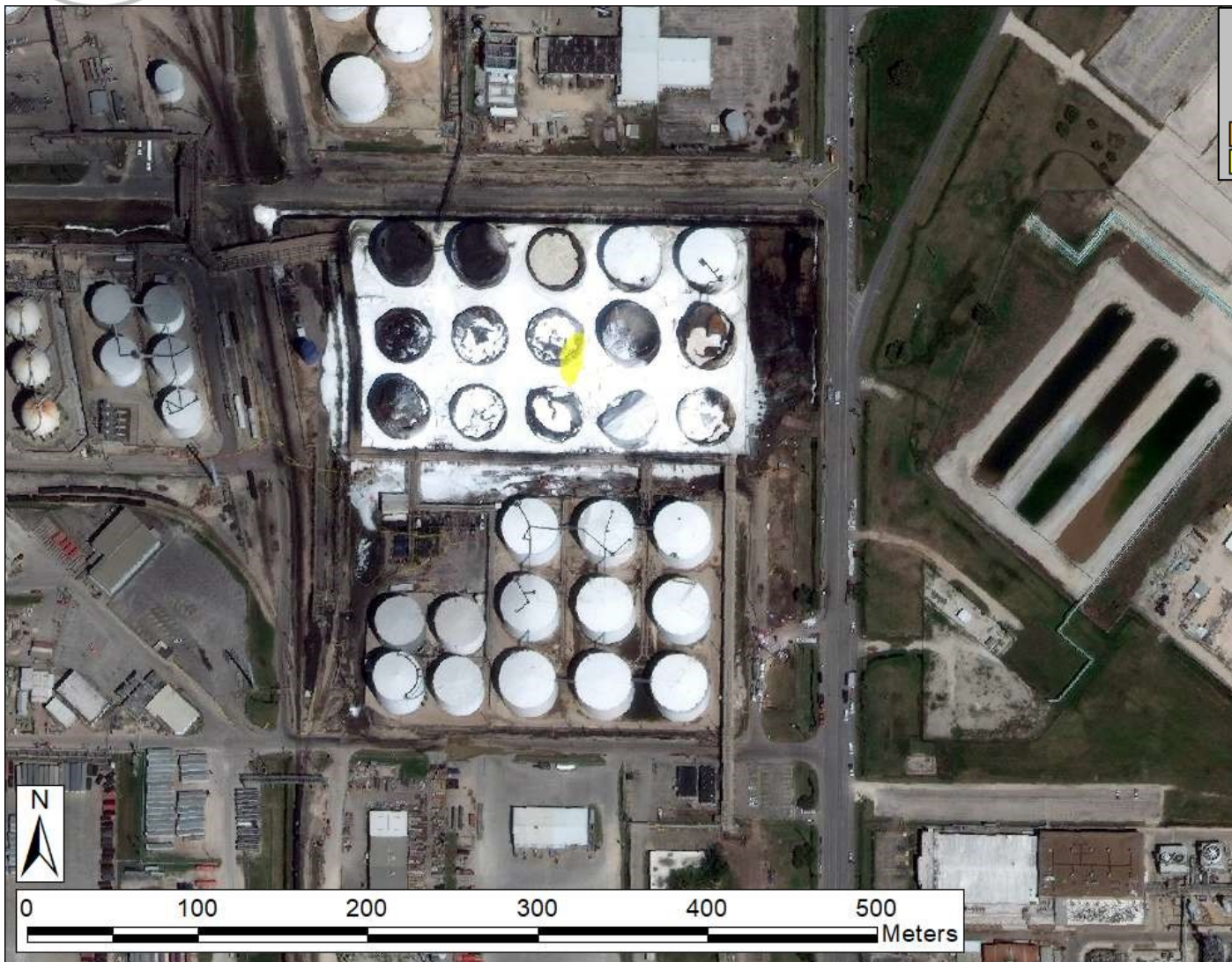
Static Population Estimates:

LandScan 2017



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AEGL Effects; 0400 26-MAR – 1200 CDT 26-MAR



Benzene(AEGLs)	
AEGLs	
26-Mar-19 17:00:00Z (8.000 hr)	
	Value
AEGL-2 Injury Possible	2.0
AEGL-1 Threshold	1.0

FACTS

Deer Park, TX

Location: 29.732437° N / 95.091517° W

Event Time: 0400 CDT, 26MAR2019

Type: Benzene

Amount: 30 kg/min

Weather: 12 km NAM

Model: HPAC 6.5

Static Population Estimates:

LandScan 2017



Acute Exposure Guideline Levels (AEGL)

Value	Description
AEGL-3	Death Possible - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
AEGL-2	Injury Possible - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
AEGL-1 (May not be displayed or defined)	Threshold - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. It is believed that the recommended exposure levels are applicable to the general population including infants and children, and other individuals who may be susceptible.

FINAL AEGLs – may be used on a permanent basis by all federal, state and local agencies, and private organizations.

INTERIM AEGLs – represents the best efforts of the AEGL Committee to establish exposure limits, and the values are available for use as deemed appropriate on an interim basis by federal and state regulatory agencies and the private sector.

Notes: Casualty numerical figures are based upon a population database (LandScan). LandScan is based on the 2010 census for the U.S. (other nations vary), overhead imagery, geo-economic, and other observable data and was updated in 2017. The population numbers next to associated hazard levels are the people contained within the entire contour based **upon average day and night** time LandScan 2017 data. **Also available are the average day or night** time LandScan 2016 data (US only). For planning purposes, estimates are assumed to be accurate within +10/-5%. Validation testing indicates agreement within 20% for select examined areas. The population data will not predict major shifts in personnel such as relocations (i.e.: religious pilgrimages, refugees, evacuations), events (i.e.: inaugurations, Olympics), or other population shifts. In such cases the population database needs to be updated to reflect actual conditions.